EDWARD J. MARKEY
7TH DISTRICT, MASSACHUSETTS

ENERGY AND COMMERCE COMMITTEE
RANKING MEMBER
SUBCOMMITTEE ON
TELECOMMUNICATIONS AND
THE INTERNET

SELECT COMMITTEE ON
HOMELAND SECURITY

RESOURCES COMMITTEE

Congress of the United States
House of Representatives
Washington, DC 20515–2107

2108 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515–2107
(202) 225–2836

DISTRICT OFFICES:

5 HIGH STREET, SUITE 101
MEDFORD, MA 02155
(781) 396–2900

188 CONCORD STREET, SUITE 102
FRAMINGHAM, MA 01702
(508) 875–2900
www.house.gov/markey

March 10, 2003

The Honorable Tom Ridge
Secretary
Department of Homeland Security
Washington, D.C.

Dear Mr. Secretary:

I am writing to call your attention to a recent communication that I received from Professor Jerry Havens of the University of Arkansas regarding the vulnerability of liquefied natural gas (LNG) vessels to terrorist attacks.

As you know, I have long been interested in the issue of LNG safety and security due to the fact that one of the nation's largest LNG importation terminals, the Distrigas facility, is located in the City of Everett, which is part of the Seventh Congressional District of Massachusetts.

I recently received a copy of a February 29, 2004 letter from Professor Havens to you on this subject (see Attachment 1). In this letter, Professor Havens notes the potential role that the failure of fire-protective insulation systems may have played in the September 11th terrorist attacks against the World Trade Center in New York. He then notes that a roughly analogous problem could affect the insulation systems used on most LNG tanker ships.

Professor Havens reports that the insulation used on most LNG tanker ships is "frequently composed of various configurations of foamed plastic insulation." While "such insulation is ideal for limiting the heat leak from the surroundings to the LNG cargo, typically -165 degrees Centigrade," Professor Havens suggests that "most, if not all, foamed plastic insulation materials melt and become ineffective as thermal insulation at temperatures of a few hundred degrees Centigrade, far below the temperatures they could experience in a fire."

In his letter, Professor Havens states that the melted foamed plastic insulation materials pose an additional fire risk, "since most will burn" and that "fire resistant insulations are not routinely applied over the foamed plastic insulations that maintain the LNG cargo temperatures." He therefore expresses the very serious concern that "If the cargo containment insulation were to fail in a fire, I believe that the entire LNG containment could be compromised."

In addition to the threat posed by failure of the cargo containment insulation, Professor Havens also notes a concern raised in a Lloyd's Register report prepared for Distrigas a few years ago – namely, that leaks of LNG resulting from a terrorist attack could lead to a crack and failure of the steel ship structure, resulting in a structural compromise that could lead to a danger of explosions of gas-air mixtures in confined areas of the ship resulting in the loss of the tanker and burning of its contents.

Professor Havens suggests that while some previous attention has been focused on the issue of cracking and fracturing of the steel structure of an LNG tanker in an accident or a terrorist attack, this threat, as well as the previously unanalyzed (to his knowledge) risk of a fire that melts the foamed plastic insulation, need to be more thoroughly analyzed and protected against. Recently, he provided my staff with some additional documentation of his concerns regarding the lack of fire protection for LNG tanker cargo insulation, which I am enclosing (see Attachment 2).

It appears to me that the issues that Professor Havens has raised merit very serious examination. I am aware of the fact that both the Department of Energy's (DOE's) Laboratory and the Federal Energy Regulatory Commission (FERC) are currently undertaking studies examining some LNG safety and security issues. In his letter, Professor Havens urges the Department to consider the tanker vulnerability issue as well. I believe that this suggestion has merit, particularly given the Coast Guard's role in protecting LNG tankers transiting through U.S. harbors.

I would therefore request that the Department look into the issues that Professor Havens has raised at once, and inform me whether the risks that he posits are real, and if so, what actions the Department, the Coast Guard, or DOE and FERC are taking to address this risk.

For example, the document that Professor Havens provided my staff quotes a study which suggests that the fire protection problem could "be resolved by two different insulating materials, the inner layer being a low-temperature insulation, and the outer layer a high-temperature insulation for protection against fire hazard." Are all LNG tankers delivering cargos to importation terminals in the U.S. being equipped with such double-layered insulating materials? If not, should they be? What about LNG tankers serving the Distrigas facility in Everett, Massachusetts? Should they be required to be equipped with double-layered insulating materials? If not, why not?

Finally, in his memo to my staff, Professor Havens says:

> If the insulation were thus compromised, the LNG would boil off much more rapidly. I do not have the information necessary to determine the ability of the relief valves on such tanks to relieve the resulting pressure, but the relief valves would not ordinarily be designed to allow the large flows that would result. If the relief valves could not relieve the pressure, the tank would be vulnerable to

rupture, as the design pressures for such tanks is relatively small because they are not pressure vessels.

Has any analysis been undertaken to examine the ability of the relief valves on the tanks in an LNG tanker ship to relieve the increased pressure resulting from a fire that melts the foam plastic insulation surrounding the tanks and causes the LNG to boil off more rapidly? Are these relief valves designed to allow the large flows that would result? If the relief valves could not relieve the pressure, do you agree that the tank would be vulnerable to rupture? Has any consideration been given to requiring the relief valves to be modified so as to better relieve the pressure that would result from such an accident/attack scenario? If so, what action is being taken? If not, why not?

Thank you for your assistance and cooperation in this matter. If you have any questions about this request, please contact Mr. Jeffrey S. Duncan of my staff at 202-225-2836.

Sincerely,

Edward J. Markey
Member of Congress

Enclosures

Cc: The Honorable Spencer Abraham
Secretary, Department of Energy

The Honorable Pat Wood
Chairman, Federal Energy Regulatory Commission

Admiral Thomas H. Collins
Commandant, United States Coast Guard

UNIVERSITY of ARKANSAS

3202 Bell Engineering Center • Fayetteville, Arkansas 72701-1201 • (479) 575-4951 • (479) 575- 7926 (FAX)

College of Engineering
Department of Chemical Engineering

Address for reply:
Chemical Hazards Research Center
U of A Engineering Research Center
700 Research Center Blvd.
Fayetteville, AR 72701
(479) 575-2055
(479) 575-8718 (Fax)

February 29, 2004

The Honorable Tom Ridge
Secretary
Department of Homeland Security
Washington, DC 20528

Dear Secretary Ridge,

I am writing you to request the Department's careful consideration of the vulnerability of LNG tank vessels to terrorist attack. Appreciating the sensitivity of such a suggestion, and the current public interest in LNG safety, I have decided after careful consideration that this direct approach to you is warranted.

I stated in recent articles in the Bulletin of the Atomic Scientists that it should not be assumed that LNG ship spills could be limited to a single tank that was initially ruptured. As there is no dispute that the fire from a single-tank spill could engulf a tanker, it is important to consider the vulnerability of an LNG ship to such a release and the pool fire that could follow.

We know now that the terrorist attack on 911 caused the World Trade Towers to collapse as a result of the structural steel in the building losing its strength because of fire exposure. That exposure was worsened by the failure of the fire-protective insulation applied to the steel structure. The insulation does appear to have been displaced by the forces of impact of the airliner with the building, rather than as a result of the insulation's lack of fire resistance – but there is no question that the building would have withstood the fire longer, perhaps even long enough for additional remedial actions to have been taken, had not the fire protection (insulation) system been compromised. It is my opinion that the terrorists may have been aware of this possibility since such structural fire protection measures have been a cornerstone of fire engineering practice for many years.

I have reviewed the information that I could find, admittedly not complete, that describes the different cargo containment systems used for LNG ships. The insulation systems on such ships are frequently composed of various configurations of foamed plastic insulation. Although such insulation is ideal for limiting the heat leak from the surroundings to the LNG cargo, typically -165 degrees Centigrade, most, if not all, foamed plastic insulation materials melt and become ineffective as thermal insulation at temperatures of a few hundred degrees Centigrade, far below the temperatures they could experience in a fire. Further, the melted insulations pose an added fire risk since most will burn. To my knowledge, fire resistant insulations are not routinely applied over the

foamed plastic insulations that maintain the LNG cargo temperatures. If the cargo containment insulation were to fail in a fire, I believe that the entire LNG containment could be compromised.

A recent report by Lloyd's Register prepared for the Boston LNG facility (Everett, MA) included some consideration of another vulnerability issue, long recognized. Leaks of LNG aboard ships have occurred and such leaks have resulted in cracks and failure of the steel ship structure. It is well known that steel used in these ship's structures is embrittled by exposure to LNG temperatures. In this case the strength of the steel is compromised by extremely low temperature, whereas the steel in the WTTs was compromised by extremely high temperature. The Lloyd's report indicated the possibility that even small leaks could result in structural compromise, and that in combination with the danger of explosions of gas-air mixtures in confined areas in the ship, could cause a chain of events that could result in the total loss of the tanker and the burning of its contents. Because of its importance to the Port of Boston, which contains the only urban LNG importation terminal in the country, I am copying this letter to Congressman Markey's office for their information.

It is my understanding that the Department of Energy and the Federal Energy Regulatory Commission are reviewing the questions of vapor dispersion and thermal radiation hazards that could result from an attack on an LNG vessel. I look forward to the results of both reviews. With this letter, I am respectfully requesting that your department consider the tanker vulnerability issues as well.

In closing, I want to state that I believe that natural gas is one of our treasured natural resources, and I am not suggesting that it is more hazardous than many other cargos in commerce. But I believe that LNG containment systems, designed currently to concentrate an immense amount of energy in liquid form, must be treated with care and respect for the potential consequences of a release. Furthermore, I do not want to aid terrorists, hence my appeal to you for consideration of my questions in a forum that will serve us all and will help us to deal with the terrorist threat. Of course, I stand ready to explain my concerns, and to assist your office in any way I can.

Sincerely,

Jerry Havens

Jerry Havens
Distinguished Professor of Chemical Engineering

cc: Congressman Markey, Congressman Boozman, Senators Lincoln and Pryor

Attachments: Havens Brief Resume
Bulletin of Atomic Scientists Article, July-Aug Issue, 2003
Bulletin of Atomic Scientists Article, Jan-Feb Issue, 2004

UNIVERSITY of ARKANSAS

Chemical Hazards Research Center
University of Arkansas
700 West 20th Street
Fayetteville AR 72701 USA
501 575-2055
fax: 501 575-8715

Fax Transmittal

Please Deliver to:

Congressman Markey/Jeff Duncan

This is page 1 of a 3 page transmission.

Time sent: _____ Date sent:_____

Message:

This is to provide some explanation about concerns raised by my recent letter to DHS about possible vulnerability of LNG tank vessels to terrorist attack.

There are two issues:

1. Brittle fracture susceptibility of ship's structural steel

I don't think this needs expansion, since it has been recognized from the earliest days of LNG marine carriage. The specifics are clearly described in the Lloyds's report prepared for Tractebel following 911. I believe your office has a copy. The bottom line is that even small leaks of LNG could compromise the structural

integrity of the ship, possibly contributing to cascading failures of the containment system.

2. <u>Lack of fire protection for the cargo tank insulation.</u>

To my knowledge, this question has not been raised before in the context of LNG ship tank containment systems. My concern is that an LNG ship tank which is exposed to fire (following even the spill of a fraction of a shiptank's content) would compromise the foamed plastic insulation on the tank, by melting or burning (or both). If the insulation were thus compromised, the LNG would boil off much more rapidly. I do not have the information necessary to determine the ability of the relief valves on such tanks to relieve the resulting pressure, but the relief valves would not ordinarily be designed to allow the large flows that would result. If the relief valves could not relieve the pressure, the tank would be vulnerable to rupture, as the design pressures for such tanks is relatively small because they are not pressure vessels.

I quote from *Pressure-Relieving Systems for Marine Cargo Bulk Liquid Containers*, published by the National Academy of Sciences, Washington, D.C. 1973 -

"Insulation may provide very substantial protection to liquid cargoes during fire exposure by reducing the heat flux from fire to the liquid cargo. This protection is provided only if the insulation sheath maintains its integrity during the fire ... Surface temperatures higher than the safe maximum value may result in deterioration of the insulation material. Materials adequate for low-temperature service may not be able to withstand high temperatures and may therefore fail when exposed to fire" - page 121

"The properties of some insulating materials are shown in the Table G-3. The first three materials in this table are used to insulate the refrigerated liquid cargo containers; they are selected on account of their suitability as low-temperature insulators. It is evident that the maximum temperatures for these three materials are much lower than those that would be attained during fire exposure. Exposure to fire could result in their decomposition, melting, or deformation ... For refrigerated cargoes, this problem can be resolved by two different insulating materials, the inner layer being a low-temperature insulation, and the outer layer a high-temperature insulation for protection against fire hazard." - page 128-129

One of the insulation materials referred to above is foam polystyrene, which is widely used as low temperature insulation on LNG ships. As I stated in my letter, I can find no evidence that a high-temperature insulation covering is used to protect this low-temperature insulation. I am asking for an evaluation of this question to ensure that LNG carriage is made as safe as practicable.

From:
Jerry Havens, Distinguished Professor of Chemical Engineering